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Environmental Control Services

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Source Testing for Sulfur Dioxide Gas and Sulfuric Acid Mist Emissions from Border Chemical Company Limited, Day Street and Gunn Road, Winnipeg, Manitoba.

1984

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ABSTRACT

In July 1984 a series of isokinetic source emission tests were conducted on the absorption tower stack at Border Chemical Company Limited. During the testing program sulfur dioxide gas and sulfuric acid mist emissions were found to average 4.8 lbs/ton (2.4 kg/tonne) and 0.4 lbs/ton (0.2 kg/tonne) respectively of 100% sulfuric acid produced. This is in compliance with Clean Environment Commission Order No. 730VC limiting sulfur dioxide gas and sulfuric acid mist emissions to 27 lbs/ton (13.5 kg/tonne) and 0.5 lb/ton (0.25 kg/tonne) respectively of 100% sulfuric acid produced.

INTRODUCTION

In June 1977 the Clean Environment Commission of Manitoba issued Order No. 730 to Border Chemical Company Limited, located at the north east corner of Day Street and Gunn Road in the Rural Municipality of Springfield, Manitoba. A request by Border Chemical for a varied Order was granted on March 22, 1978. Clause 1 of the new Order, known as Order No. 730VC, stipulated that sulfur dioxide gas from the discharge stack shall not exceed 27 lbs/ton of 100% sulfuric acid produced. Clause 2 of the new Order, unchanged from the original Order, stipulated that sulfuric acid mist emissions from the discharge stack shall not exceed 0.5 lbs/ton of 100% sulfuric acid produced.

Stack sampling in October 1978 revealed that sulfur dioxide gas averaged 13.0 lbs/ton of 100% sulfuric acid produced, while sulfuric acid mist averaged 0.7 lbs/ton of 100% sulfuric acid produced. This was in non-compliance with Clause 2. The company indicated that this was due to poor absorber efficiency and proceeded to clean the absorber packing.

During October and November 1979 further stack sampling was conducted. Sulfur dioxide gas and sulfuric acid mist emissions were found to be 7.9 and 0.4 lbs/ton respectively of 100% sulfuric acid produced. No further action was deemed necessary other than routine inspections by an Environmental Officer of Air Pollution Control.

In July 1984 Border Chemical was re-sampled in response to citizen complaints and high opacity emissions observed on occasion by an Air Pollution Control Environmental Officer.

PROCESS DESCRIPTION

Border Chemical Company Limited converts high purity elemental sulfur (99.984%) into industrial grade sulfuric acid (H_2SO_4) using the single contact process. The plant is of Monsanto design and has a rated capacity of 408 tonne/day, however this can be increased to 454 tonne/day without significant loss of conversion efficiency. This is typical of manufacturer over capacity design to ensure high conversion efficiency, typically between 97 and 98.5%.

Elemental sulfur is brought into the plant in totally enclosed railway tank cars (see Figure 1 for process flow diagram). Steam is used to melt the sulfur and keep it molten after it is transferred to an underground storage chamber, where impurities are allowed to settle out. The molten sulfur, kept at a temperature of 132°C is filtered and then pumped into a sulfur furnace where it is burned with dried air resulting in the formation of sulfur dioxide gas (SO_2). Water is removed from the combustion gas by passing it through a drying tower where sulfuric acid is used as a drying agent.

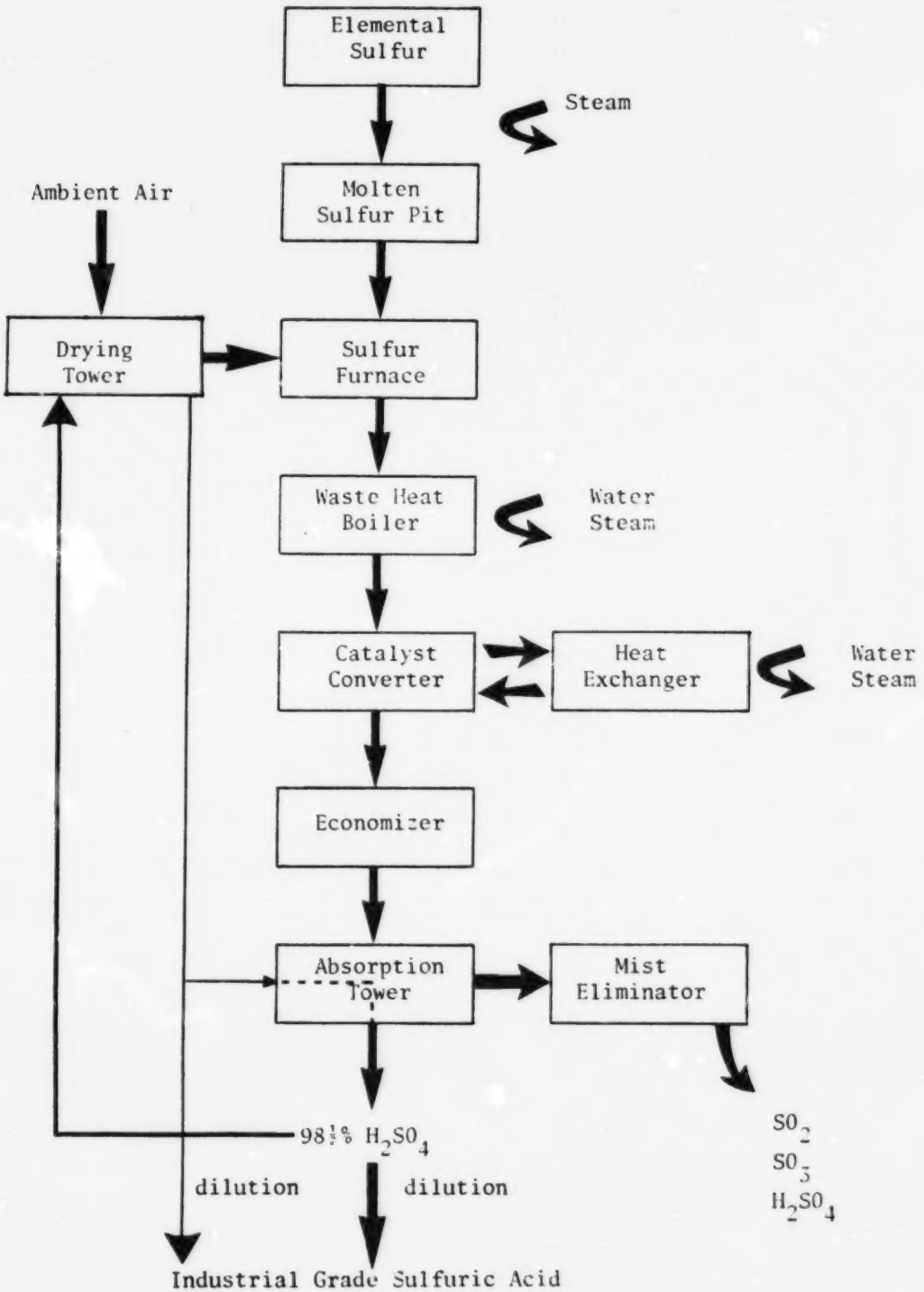
From the furnace the hot gaseous mixture, containing 7 to 11 percent SO_2 by volume, is cooled in a waste heat boiler before being passed into a catalyst converter. The heat that is removed from the sulfur combustion products is used to produce steam. Solid vanadium pentoxide (V_2O_5) catalyst is placed in five horizontal beds where 97 to 98.5 percent of the SO_2 is oxidized to SO_3. Considerable heat is released during the oxidation process which

decreases conversion efficiency which is optimum between 400° and 450°C. A heat exchanger removes this excess heat which is used to convert water to steam.

After leaving the converter the sulfur trioxide and air mixture is further cooled in an economizer to permit efficient absorption in sulfuric acid. The gases enter the absorption tower at 150°C and travel counter currently in a stream of 98 percent acid falling from the top. Sulfur trioxide is absorbed by water in the acid stream yielding 98.5 percent sulfuric acid. This may be diluted by mixing with water or less concentrated acid.

The exhaust gases from the absorption tower are the major source of emissions from single contact sulfuric acid plants. The discharge gases contain unreacted sulfur dioxide, trace amounts of sulfur trioxide and droplets of sulfuric acid mist. Emissions of the latter component are controlled at Border Chemcial by an 11 glass fiber and stainless steel element Brink Mist Eliminator. The stated collection efficiency of this demister is: 100% for particles above 3 microns, 85 to 97% for particles below 3 microns but above 1 micron and 50 to 85% for particles below 1 micron and above 0.5 micron. Sulfur dioxide and sulfur trioxide are not treated after leaving the absorption tower.

FIGURE 1. Sulfuric Acid Manufacturing Process Flow Diagram.



PROCESS SCHEDULE

During the sampling period Border Chemical Company Limited produced approximately 225 tons per day of 98.5 % sulfuric acid. This is equivalent to 221.6 tons per day of 100% sulfuric acid.

TEST PROCEDURES

Testing was conducted according to the United States Environmental Protection Agency Method 8. Figure 2 depicts the sample collection system. The sample was drawn into the nozzle, through a glass lined probe and into impinger No. 1 which was loaded with 100 ml of 80% isopropyl alcohol in deionized water. This solution was used to trap the preferentially soluble sulfuric acid mist (including sulfur trioxide). A filter was inserted before impinger No. 2 to eliminate any sulfur trioxide carryover. The second impinger, a modified type, was loaded with 100 ml of 3% hydrogen peroxide, as was impinger No. 3 which was of the standard design. The two peroxide solutions oxidized sulfur dioxide gas to sulfur trioxide. The last impinger was loaded with 200g of indicating silica gel which removed moisture from the gas sample. All impingers were of 500 ml capacity.

A Bendix Series 4500 isokinetic Stack Sampler was used to extract the samples from the absorption tower exhaust stack. Gas velocity in the stack was measured with a S type pitot tube and a Dwyer Model 2000-00AV Magnehelic Differential Pressure Gauge (range 0 to 0.25" H_2O, minor division 0.005" H_2O). Dry gas meter and pitot tube calibration sheets are located in Appendix A. A Hays-Republic Model 621A Gas Analyzer was used to determine CO_2 (Carbon Dioxide), O_2 (Oxygen) and CO (Carbon Monoxide) content of the stack gas. Stack temperature was measured by a K type thermocouple.

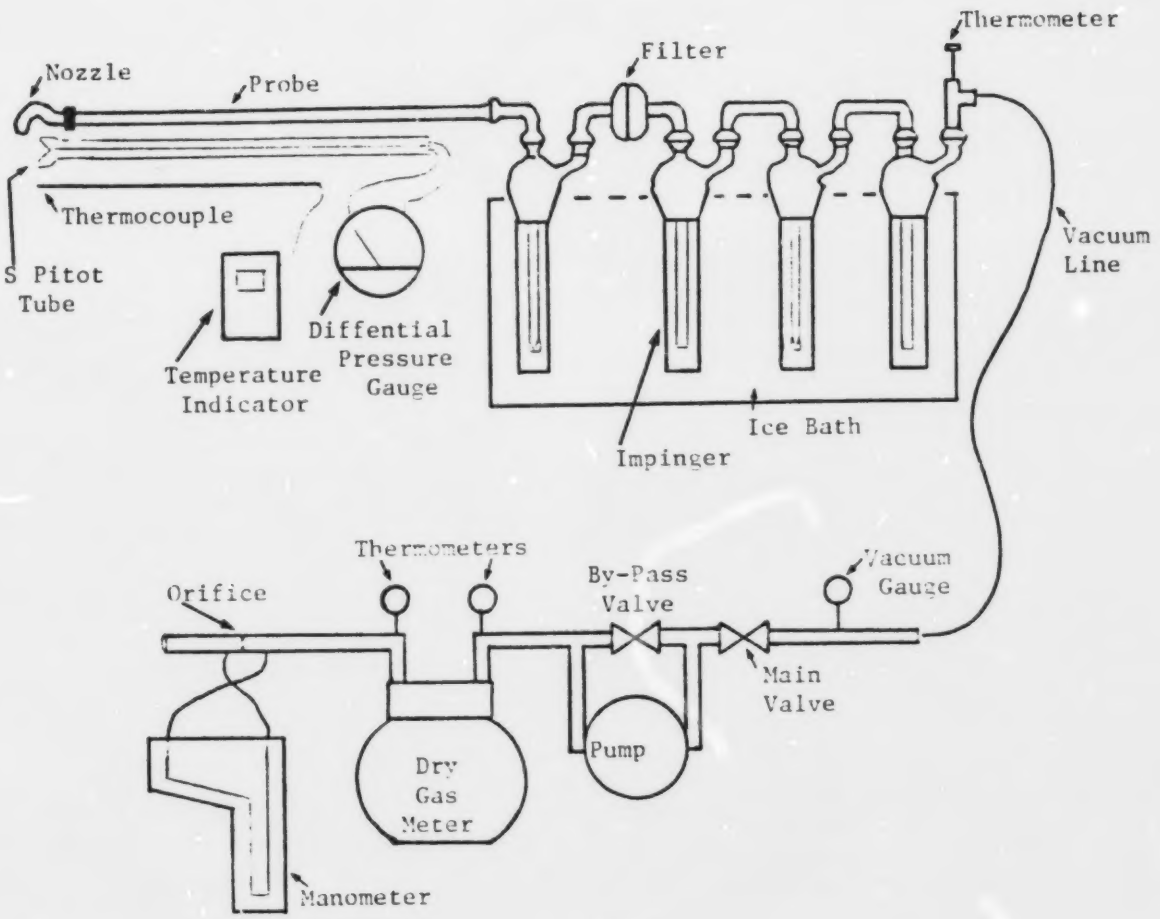


FIGURE 2. SAMPLE COLLECTION SYSTEM FOR SULFUR DIOXIDE GAS AND SULFURIC ACID MIST.

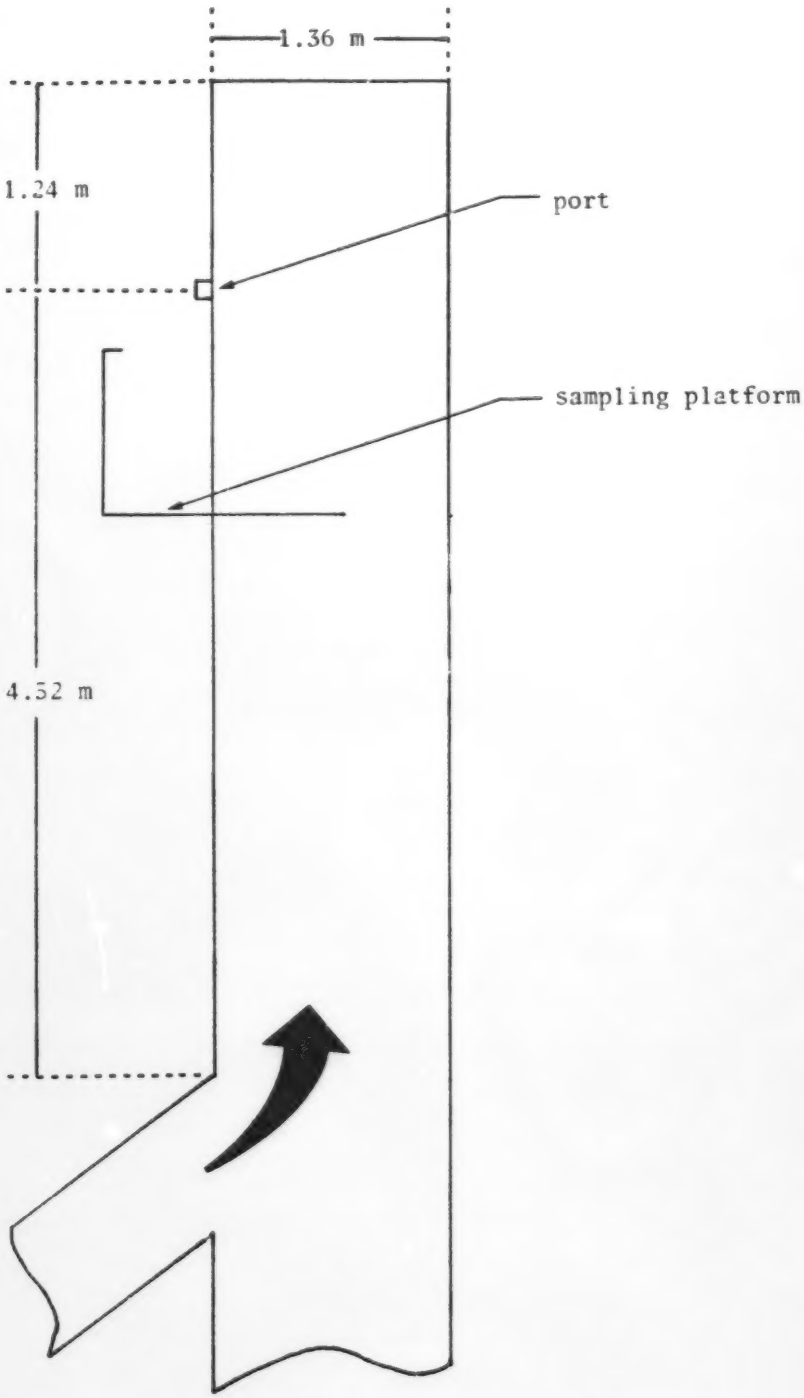
The sampling was conducted from two ports, at right angles to each other, located 4.52 metres (3.3 stack diameters) downstream from the breaching. These ports were 1.24 metres (0.9 stack diameters) from the top of the stack. The absorption tower exhaust stack is depicted in Figure 3. Twelve points were sampled along each traverse (a total of 24 points per test) to ensure that a representative sample was collected. The stack had a continuous inside diameter of 1.36 metres. The sample points, located at 2.9, 9.1, 16.0, 24.1, 34.0, 48.3, 87.7, 102.0, 111.9, 120.0, 126.9 and 133.1 cm from the sampling port, are depicted on a cross section of the stack in Figure 4.

The three emission tests were conducted on July 10, 11 and 12, 1984.

The sampling team consisted of Kevin Reeve and Tim Higham.

The samples were submitted to the W. M. Ward Technical Services Laboratory for analysis.

FIGURE 3. Absorption tower exhaust stack.



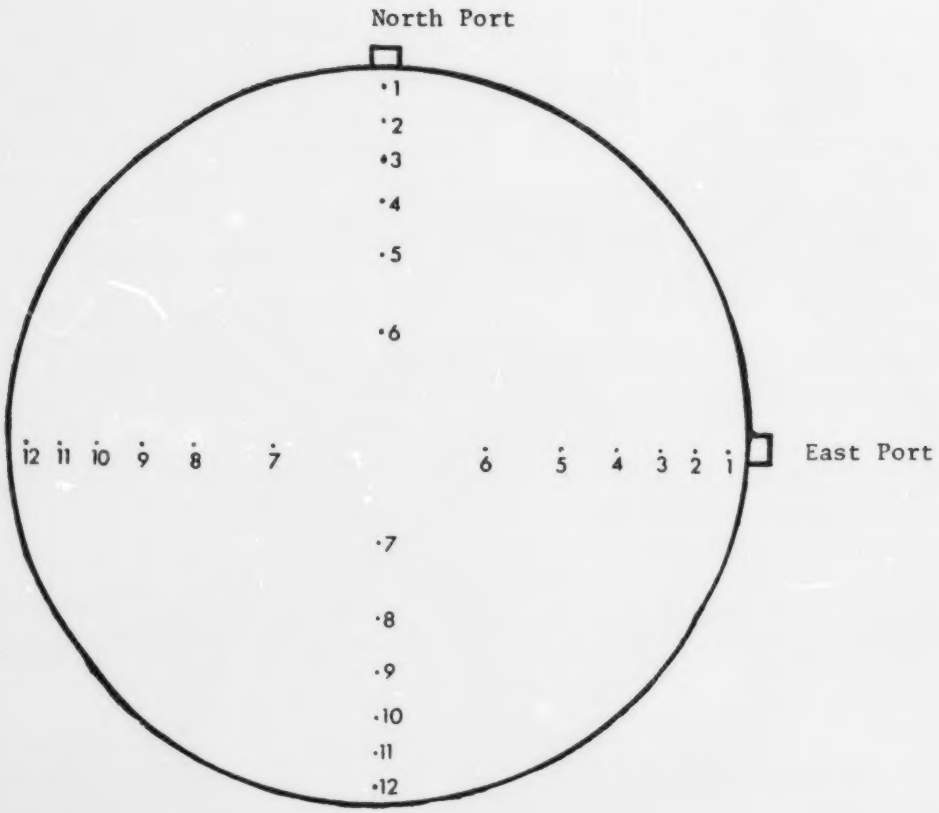


FIGURE 4: Stack Cross Section Showing Sample Points.

RESULTS

Stack velocity profiles, which were quite uniform and characteristic throughout the testing program, are illustrated in Graphs 1 through 6 in Appendix B. Some of the more important sampling variables are summarized in Table 1. Refer to Appendix C for field data.

Source emission data are summarized in Table 2. The laboratory analysis report is located in Appendix D.

TABLE 1: SUMMARY OF SAMPLING VARIABLES

TEST NUMBER	1	2	3
SAMPLING DATE	July 10, 1984	July 11, 1984	July 12, 1984
SAMPLING DURATION, minutes	120	120	120
SAMPLING VOLUME @ METER CONDITIONS, m^3	1.2348	1.1589	1.3314
SAMPLING VOLUME @ STANDARD CONDITIONS, dscm*	1.1436	1.0954	1.2283
AVERAGE GAS METER TEMPERATURE, °C	40	34	41
ORIFICE PRESSURE DROP, mm H_2O	10.46	9.37	12.14
STACK STATIC PRESSURE, mm H_2O	+0.51	+0.51	+0.51
AVERAGE STACK GAS TEMPERATURE, °C	70	72	67
AVERAGE STACK GAS VELOCITY, m/s	2.7	2.6	2.9
ISOKINETIC FACTOR, %	102.7	103.4	102.7

*Standard Conditions are 20°C and 760 mm Hg

TABLE 2: SOURCE EMISSION SUMMARY

TEST NUMBER		1	2	3	AVERAGE
STACK GAS COMPOSITION DRY BASIS, % BY VOLUME	CO_2	0.0	0.0	0.0	-
	O_2	12.5	12.5	12.5	-
	CO	0.0	0.0	0.0	-
STACK GAS MOISTURE % BY VOLUME		0.3	0.4	0.3	-
M_s**, g/g-mole		28.47	28.46	28.47	-
AVERAGE STACK GAS VOLUMETRIC FLOW RATE, dscm/h		11,780.7	11,187.3	12,677.8	11,881.9
CONCENTRATION OF SULFUR DIOXIDE IN THE STACK GAS, g/dscm		1.68	2.02	1.43	1.71
EMISSION RATE OF SULFUR DIOXIDE, lb/ton (kg/tonne) of 100% SULFURIC ACID		4.7 (2.35)	5.4 (2.70)	4.3 (2.15)	4.8 (2.40)
CONCENTRATION OF SULFURIC ACID MIST*** IN THE STACK GAS, g/dscm		0.14	0.19	0.13	0.15
EMISSION RATE OF SULFURIC ACID MIST*** lb/ton (kg/tonne) of 100% SULFURIC ACID		0.4 (0.20)	0.5 (0.25)	0.4 (0.20)	0.4 (0.20)

** Molecular Weight of the Stack Gas on a Wet Basis
*** Includes Sulfur Trioxide

DISCUSSION

The emission rate of sulfur dioxide gas at Border Chemical compares favorably with that of other single absorption plants. Typical conversion efficiency is 97 to 98.5% which results in sulfur dioxide gas emissions of 40 to 20.5 lbs per ton of acid produced.

Conversion efficiency is affected by the amount and number of beds of catalyst and temperature, pressure and concentration of reactant gases. The factor that probably reduces sulfur dioxide gas emissions the most at Border Chemical is the use of a five bed converter rather than the normal four bed converter. This allows the reactant gases to remain in contact with the catalyst for a longer period of time, which increases the conversion of sulfur dioxide to sulfur trioxide.

CONCLUSION

The results of the tests indicate that during the survey the average sulfur dioxide gas emission was 4.8 lb/ton (2.4 kg/tonne) of 100% sulfuric acid produced. The average sulfuric acid mist emission during the testing was 0.4 lb/ton (0.2 kg/tonne) of 100% sulfuric acid produced.

Emissions of sulfur dioxide gas and sulfuric acid mist were below the limits of Clean Environment Commission Order No. 730VC, indicating compliance during the testing program.

BIBLIOGRAPHY

1. "Production and Use of Sulfuric Acid". Canadian Industries Limited, Education Services. 1972.

2. "Standards of Performance for New Stationary Sources: Revision to Reference Methods 1-8. United States Environmental Protection Agency. Federal Register 42(160); 41,754-41,789. 1977.

3. "Sulfur Dioxide and Sulfuric Acid Mist Sampling of Absorber Stack Exhaust at Border Chemical Company Ltd., Winnipeg, Manitoba 1978". Manitoba Environmental Management Division. 1979.

APPENDIX A: Equipment Calibration Data

APPENDIX B: Velocity Profiles

APPENDIX C: Field Data Sheets

APPENDIX D: Analytical Report

APPENDIX A: Equipment Calibration Data

S-TYPE PITOT TUBE CALIBRATION

PROBE SIZE (ft) 5 — CALIBRATION # 84-13

PROBE LINER Glass — DATE March 28, 1984

PROBE MANUFACTURER RAC — BAROMETRIC PRESSURE (Hg) 29.21

TIP SIZE (inches) 0.375 — AMBIENT TEMP. (°C) 19.5

TIP TYPE SS — OPERATOR KR, AS

STACK THERMOCOUPLE ☒ PRESENT

☐ ABSENT

HP 97 INPUT/OUTPUT

Temp	19.5	°C
Bar. Press	29.21	In. Hg
Scale Factor	0.1	

3.01	Δ p (std)	
36.893078		
4.92	Δ p (s-pitot)	
0.780214		
36.900810		

7.36	Δ p (std)	
57.690002		
12.22	Δp(s-pitot)	
0.774134		
57.702092		

0.72	Δ p (std)	
Tunnel Velocity	18.043795	ft/sec
1.19	Δ p (s-pitot)	
Cp, at this	0.775900	velocity
Tunnel Velocity	18.047577	(using Cp)

4.18	Δ p (std)	
43.476021		
6.92	Δ p (s-pitot)	
0.775261		
43.485132		

8.14	Δ p (std)	
60.669971		
13.33	Δp(s-pitot)	
0.779489		
60.682694		

1.62	Δ p (std)	
27.065693		
2.66	Δ p (s-pitot)	
0.778448		
27.071365		

5.28	Δ p (std)	
48.862829		
8.61	Δ p (s-pitot)	
0.781139		
48.873069		

0.778252	Cp (ave)
0.002779	Std Dev.
8	Deg. of Freedom

2.30	Δ p (std)	
32.249691		
3.74	Δ p (s-pitot)	
0.782242		
32.256450		

6.53	Δ p (std)	
54.339825		
10.75	Δ p (s-pitot)	
0.777437		
54.351213		

2.306	t .05
0.776116	Low Cp
0.778252	Mean Cp
0.780387	High Cp

rev. 82-01

DRY GAS METER & ORIFICE METER CALIBRATION SHEET

Lab No. 11165 1/2

Dry Gas Meter S/N Berlin 711030 — Calibrated re Large Wet Test Meter

Atmospheric Pressure 29.30 in hg = 744.2 mm hg — Calibrated by Jim Pritchard & Kurt Rowe

Ambient Temperature 19°C — 22.7°C — Date 15 June 84

Manometer ΔH (in. H_2O)	W.T.M. Volume Vw ($Ft.^3$)	Dry Gas Meter Reading Initial ($Ft.^3$)	Dry Gas Meter Reading Final ($Ft.^3$)	D.G.M. Volume Vd ($Ft.^3$)	Temperature W.T.M. Tw (°F.)	Temperature W.T.M. Tw (°C.)	Temperature D.C.M. Ti (°F.)	Temperature D.C.M. To (°F.)	Time t (Min.:Sec.)	Time t (Min.)	W.T.M. Manometer Δm (in. H_2O)	Partial Pressure Ps (mm. Hg)	W.T.M.:D.G.M. Ratio γ (—)	$\sqrt{\quad}$ (—)	Flowrate @ S.T.P. Qm ($Ft.^3$/min.)
.500	4.0	881.747	885.837	4.090	64.8	18.2	101	80	10:22.39	10.3732	0.31	15.673	1.0022	0.5624	0.3977
.500	4.0	881.814	885.918	4.104	65.0	18.3	102	82	10:22.41	10.3735	0.30	15.772	1.0011	0.5634	0.3989
.500	4.0	892.003	896.113	4.110	65.1	18.4	103	83	10:24.59	10.4098	0.29	15.871	1.0011	0.5640	0.3981
1.02	4.0	898.175	902.303	4.128	65.2	18.4	110	84	7:20.67	7.3445	0.43	15.871	1.0021	0.8057	0.5501
1.02	4.0	903.335	907.468	4.133	65.3	18.5	111	85	7:21.13	7.3522	0.40	15971	1.0024	0.8065	0.5504
1.02	4.0	908.507	912.648	4.141	65.5	18.6	112	86	7:21.36	7.3560	0.38	16.071	1.0018	0.8072	0.5509
1.51	5.0	914.714	919.900	5.186	65.6	18.7	114	87	7:33.71	7.5618	0.50	16.172	1.0008	0.9824	0.6698
1.51	6.0	921.464	927.696	6.232	65.6	18.7	114	87	9:04.63	9.0772	0.48	16.172	0.9994	0.9824	0.6696
1.51	5.0	928.208	933.398	5.190	65.7	18.7	114	87	7:33.84	7.5640	0.55	16172	0.9997	0.9824	0.6694
2.03	6.0	935.436	941.709	6.233	65.9	18.8	116	88	7.54.03	7.9005	0.64	16.272	0.9995	1.1394	0.7689
2.03	6.0	942.752	948.985	6.233	66.0	18.9	116	88	7.53.56	7.8927	0.62	16.375	0.9992	1.1394	0.7694
2.03	6.0	951.017	957.298	6.231	66.1	18.9	116	89	7.53.56	7.8927	0.56	16.375	1.0004	1.1404	0.7702

Linear Regression: Intercept (b) 0.014

Slope (K) 0.665

Coefficient of Determination (r^2) 1.000

$\bar{\gamma}$ = 1.000 ± 0.001

ΔHG = 2.078

Comments:

DRY GAS METER & ORIFICE METER CALIBRATION SHEET

2/2

Dry Gas Meter S/N Rockw 711030

Calibrated re Large Wet Test Meter

Atmospheric Pressure 29.28 in hg = 743.1 mm hg

Calibrated by Jim Peterpaul & Kurt Rowe

Ambient Temperature 19.9°C — 22.7°C

Date 15 June 84

Manometer Orifice ΔH (in. H_2O)	W.T.M. Volume Vw ($Ft.^3$)	Dry Gas Meter Reading Initial ($Ft.^3$)	Dry Gas Meter Reading Final ($Ft.^3$)	D.G.M. Volume Vd ($Ft.^3$)	Temperature W.T.M. Tw (°F.)	Temperature W.T.M. Tw (°C.)	Temperature D.G.M. Ti (°F.)	Temperature D.G.M. To (°F.)	Time t (Min.:Sec.)	Time t (Min.)	W.T.M. Manometer Δm (in. H_2O)	Partial Pressure Ps (mm. Hg)	W.T.M.:D.C.M. Ratio γ (—)	$\sqrt{\quad}$ (—)	Flowrate @ S.T.P. Qm ($Ft.^3$/min.)
2.53	6.0	959.317	965.570	6.221	66.1	18.9	116	89	7.05.76	7.0960	0.52	16.375	1.0008	1.2724	0.8564
2.53	6.0	966.140	972.815	6.223	66.2	19.0	116	90	7.03.55	7.0592	0.60	16.477	1.0009	1.2735	0.8620
2.53	6.0	973.900	980.130	6.230	66.4	19.1	116	90	7.05.18	7.0947	0.60	16.581	0.9992	1.2735	0.8572
3.05	6.0	984.274	990.498	6.224	66.5	19.2	117	90	6.29.44	6.4907	0.71	16.685	0.9992	1.3974	0.9352
3.05	6.0	992.574	998.784	6.210	66.5	19.2	117	90	6.29.26	6.4877	0.63	16.685	1.0016	1.3974	0.9356
3.05	6.0	000.851	007.075	6.219	66.6	19.2	117	90	6.29.34	6.4890	0.77	16.685	0.9996	1.3974	0.9351
3.54	6.0	010.136	016.297	6.221	66.6	19.2	117	90	5.56.66	5.9443	0.70	16.685	0.9983	1.5046	1.0197
3.54	6.0	017.429	023.645	6.216	66.7	19.3	117	90	5.55.88	5.9313	0.73	16.790	0.9997	1.5046	1.0215
3.54	6.0	025.711	031.918	6.207	66.8	19.3	117	90	5.55.51	5.9252	0.72	16.790	1.0000	1.5046	1.0224

Linear Regression: Intercept (b) 0.014

Slope (K) 0.665

Coefficient of Determination (r^2) 1.000

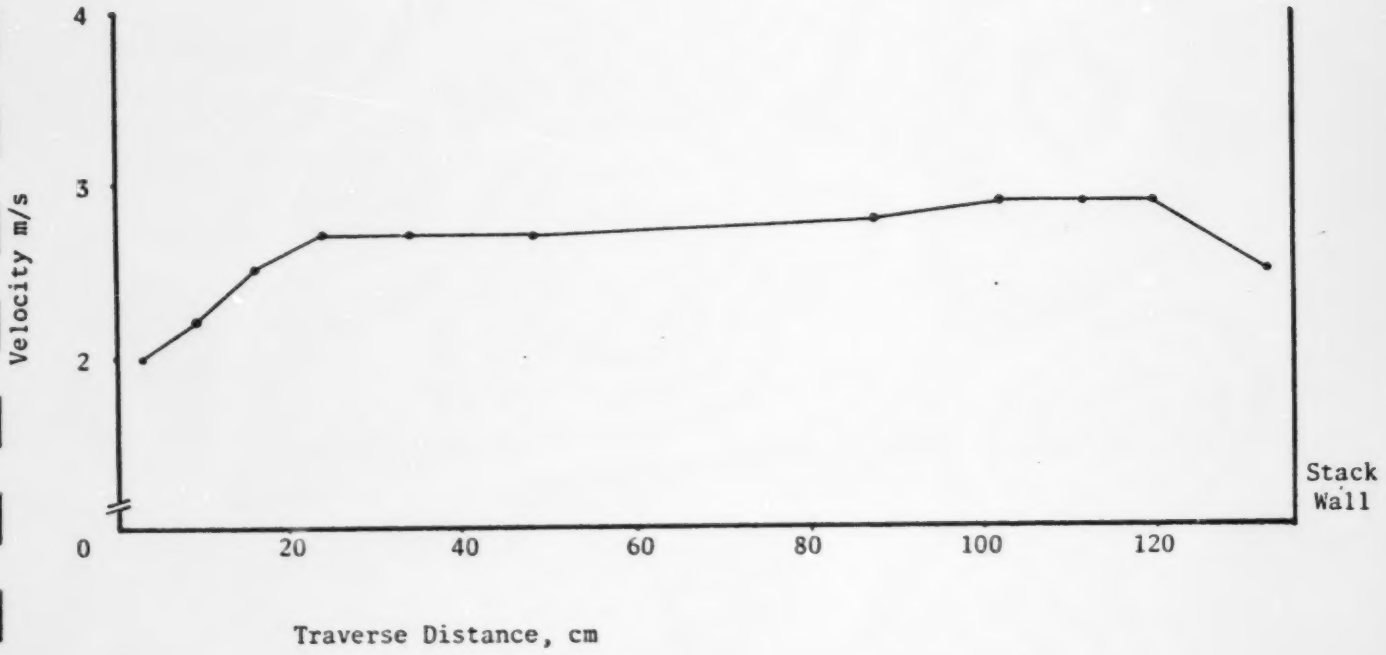
$\overline{\gamma}$ = 1.000 ± 0.001

ΔH@ = 2.078

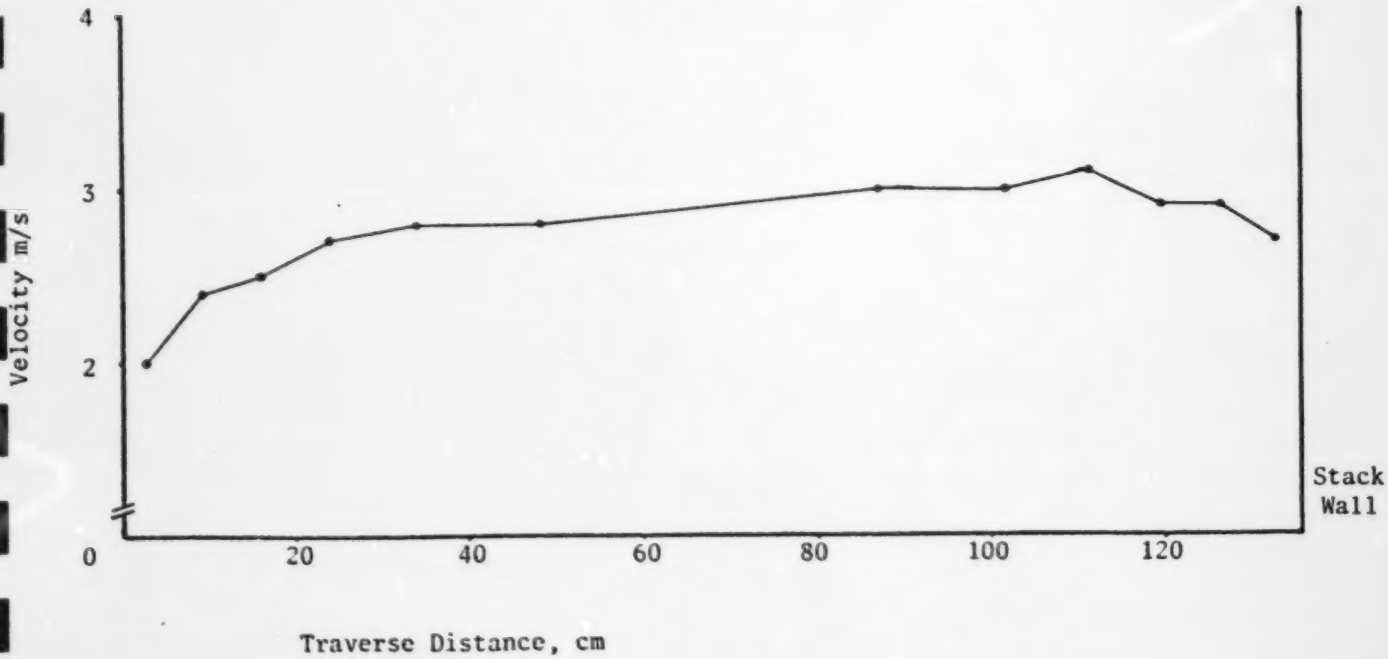
Comments:

APPENDIX B: Velocity Profiles

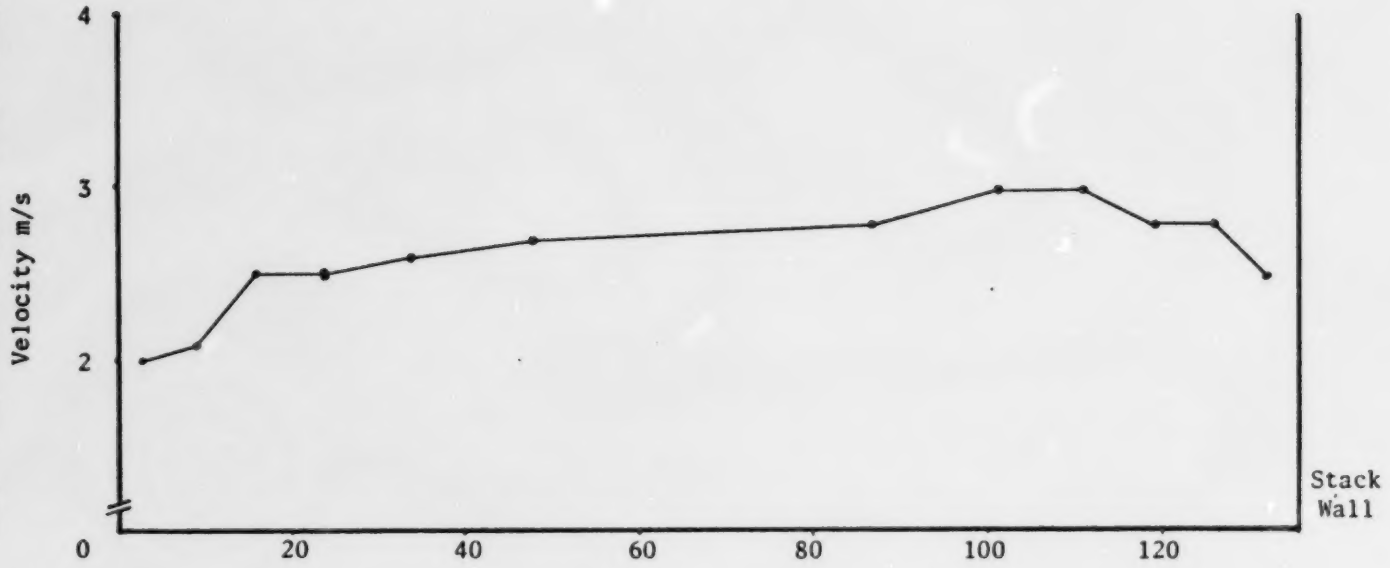
Graph 1. Velocity Profile of Test 1, East Port. Wind NW 8 km/hr



Graph 2. Velocity Profile of Test 1, North Port. Wind NW 8 km/hr

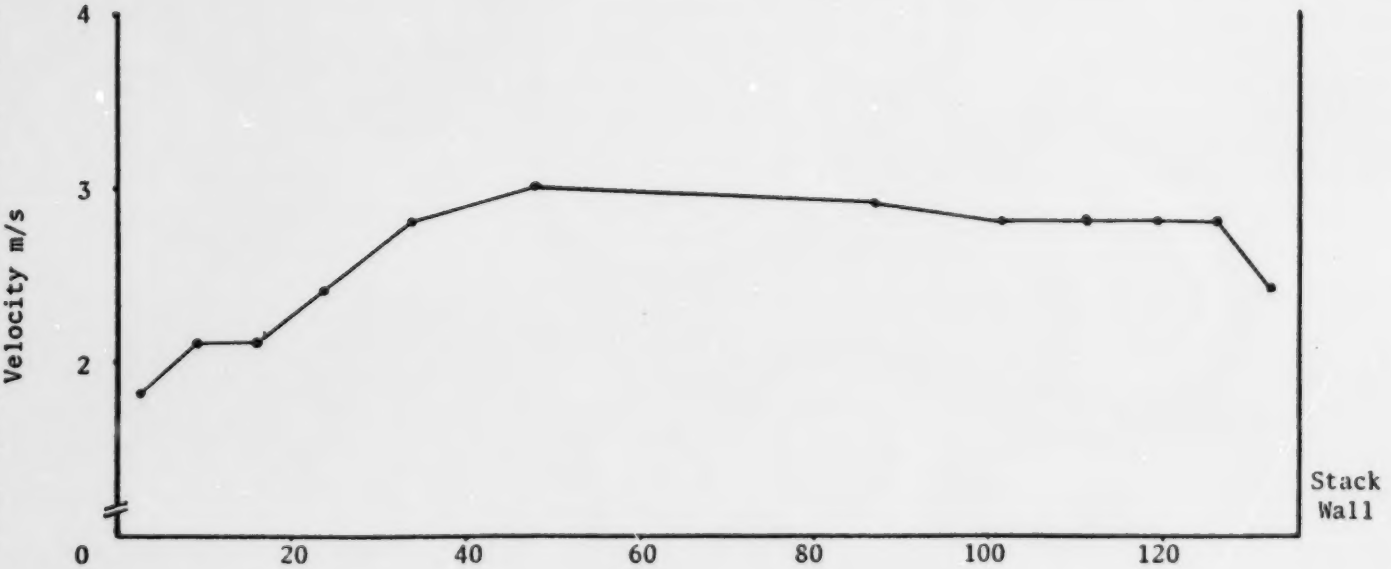


Graph 3. Velocity Profile of Test 2, East Port. Wind W 0 to 13 km/hr



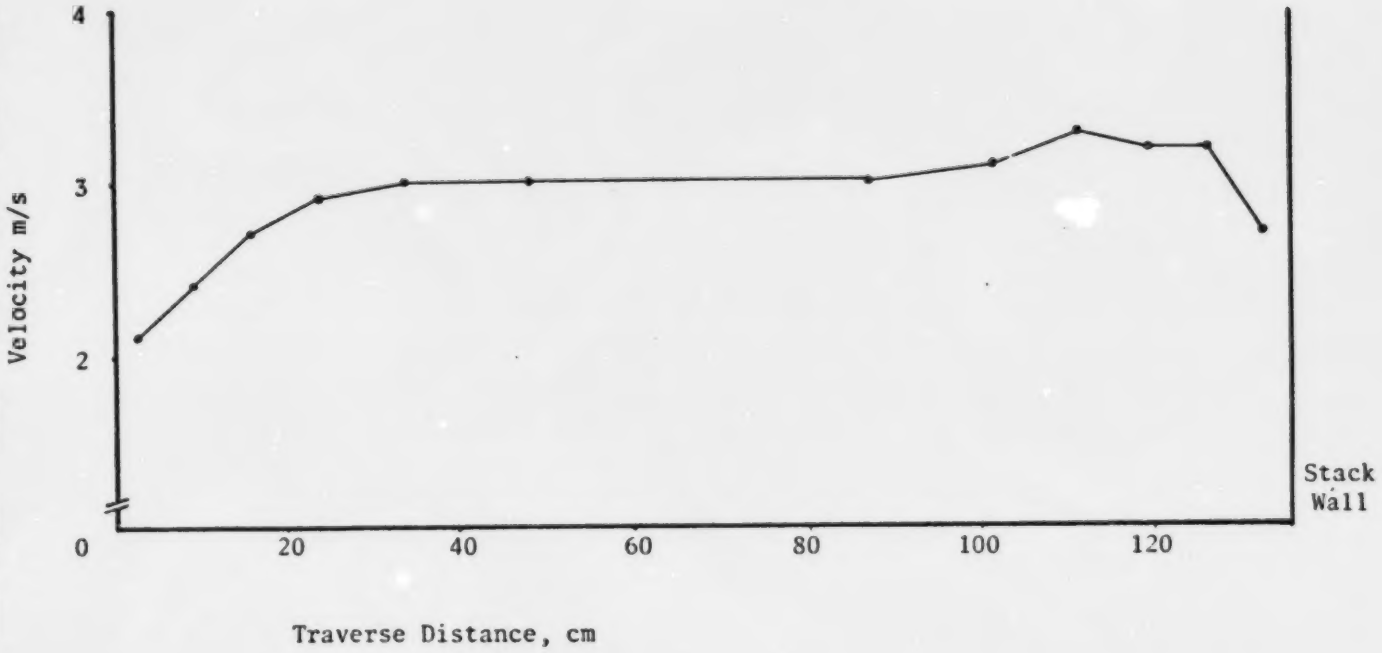
Traverse Distance, cm

Graph 4. Velocity Profile of Test 2, North Port. Wind W 0 to 13 km/hr

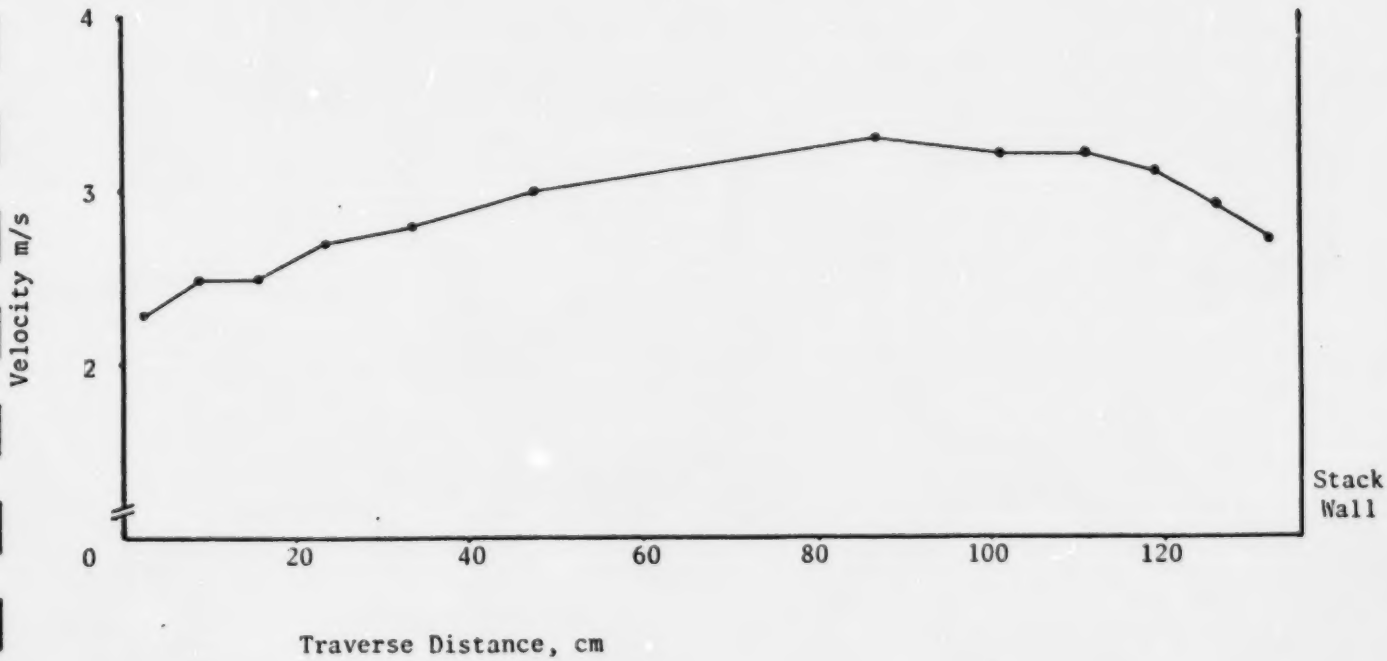


Traverse Distance, cm

Graph 5. Velocity Profile of Test 3, East Port. Wind E 5 km/hr



Graph 6. Velocity Profile of Test 3, North Port. Wind E 5 km/hr



APPENDIX C: Field Data Sheets

FIELD DATA SHEET

Plant Border Chemical Company Limited Location NE corner of Day Street and Gunn Road, R.M. of Springfield

Stack Absorber tower exhaust Test number 1 Date July 10, 1984

Ambient temperature (°F) 81 Barometric pressure (in. Hg) 29.03 Time 11:00 A.M. to 1:08 P.M.

Nozzle diameter (in.) 0.367 Probe length/type 5 foot/glass lined Stack static pressure (in. H_2O) +0.02

Probe temperature (°F) 245 to 272 Filter holder temperature (°F) _____ Leak check 0.02 CFM @ 10 " Hg Vacuum

Traverse point number	Clock time, start	Stack gas temperature, °F	Gas meter volume, cu. ft.	Velocity pressure, in. H_2O	Orifice pressure drop in. H_2O	Gas meter temperature, °F		Final impinger Temperature, °F	Pump vacuum in. H_2O	Isokinetic factor, %
						Inlet	Outlet			
E 1	0	144	1.297	0.014	0.243	83	82	68	3	97.4
2	5	152	1.418	0.016	0.273	97	84	68	3	99.9
3	10	158	1.663	0.021	0.355	103	85	67	3	102.0
4	15	160	1.765	0.023	0.388	103	86	66	3	103.5
5	20	160	1.766	0.023	0.389	103	86	65	3	103.6
6	25	159	1.821	0.024	0.407	105	88	64	4	103.9
7	30	159	1.890	0.026	0.442	109	90	65	4	102.6
8	35	159	1.986	0.028	0.477	105	90	65	4	104.8
9	40	159	1.993	0.028	0.477	105	91	65	4	105.1
10	45	158	1.942	0.027	0.462	105	92	65	4	104.3
11	50	158	1.948	0.027	0.463	109	93	66	4	104.2
12	55	157	1.718	0.021	0.361	112	94	66	3	103.5
Average or total										

FIELD DATA SHEET

Traverse point number	Clock time	Stack gas temperature, °F	Gas meter volume, cu. ft.	Velocity pressure, in. H_2O	Orifice pressure drop in. H_2O	Gas meter temperature, °F		Final impinger Temperature, °F	Pump vacuum in. H_2O	Isokinetic factor, %
						Inlet	Outlet			
N 1	60	147	1.423	0.014	0.246	103	94	69	3	105.3
2	65	156	1.600	0.019	0.327	109	95	68	3	101.3
3	70	156	1.683	0.020	0.347	116	96	68	3	103.2
4	75	159	1.797	0.023	0.398	119	97	67	3	102.7
5	80	161	1.882	0.025	0.431	123	100	67	3	102.6
6	85	162	1.886	0.025	0.432	124	101	67	4	102.8
7	90	161	2.064	0.030	0.520	125	102	66	4	102.0
8	95	160	2.075	0.030	0.522	130	103	67	4	101.9
9	100	160	2.122	0.031	0.540	134	106	68	4	102.5
10	105	160	2.013	0.028	0.490	138	110	68	4	101.6
11	110	160	1.977	0.027	0.476	138	112	69	4	101.7
12	115	160	1.874	0.024	0.425	135	112	69	4	102.1
Average or total	120	158	43.603	0.024	0.412	--	--	--	--	102.7

FIELD DATA SHEET

Plant Border Chemical Company Limited Location NE corner of Day Street and Gunn Road, R.M. of Springfield

Stack Absorber tower exhaust Test number 2 Date July 11, 1984

Ambient temperature (°F) 80 Barometric pressure (in. Hg) 29.05 Time 10:04 A.M. to 12:10 P.M.

Nozzle diameter (in.) 0.367 Probe length/type 5 foot/glass lined Stack static pressure (in. H_2O) +0.02

Probe temperature (°F) 222 to 272 Filter holder temperature (°F) _____ Leak check 0.02 CFM @ 10 " Hg Vacuum

Traverse point number	Clock time, start	Stack gas temperature, °F	Gas meter volume, cu. ft.	Velocity pressure, in. H_2O	Orifice pressure drop in. H_2O	Gas meter temperature, °F		Final impinger Temperature, °F	Pump vacuum in. H_2O	Isokinetic factor, %
						Inlet	Outlet			
E 1	0	146	1.271	0.013	0.226	88	81	67	3	99.4
2	5	159	1.289	0.014	0.236	94	82	66	3	97.8
3	10	160	1.615	0.020	0.339	96	82	65	3	102.8
4	15	163	1.629	0.020	0.337	99	83	66	3	102.6
5	20	164	1.681	0.021	0.353	100	84	66	4	103.3
6	25	164	1.779	0.024	0.387	100	84	65	4	103.2
7	30	164	1.913	0.026	0.438	102	85	65	4	105.9
8	35	164	1.936	0.028	0.472	104	86	65	4	102.5
9	40	164	1.969	0.028	0.473	101	86	64	4	104.6
10	45	164	1.869	0.025	0.422	102	87	65	4	105.6
11	50	164	1.875	0.025	0.423	101	87	67	4	106.0
12	55	161	1.658	0.020	0.339	98	87	69	3	105.1
Average or total										

FIELD DATA SHEET

Traverse point number	Clock time	Stack gas temperature, °F	Gas meter volume, cu. ft.	Velocity pressure, in. H_2O	Orifice pressure drop in. H_2O	Gas meter temperature, °F		Final impinger Temperature, °F	Pump vacuum in. H_2O	Isokinetic factor, %
						Inlet	Outlet			
N 1	60	155	1.109	0.011	0.186	94	86	68	3	94.4
2	65	159	1.346	0.014	0.238	97	86	68	3	101.4
3	70	160	1.415	0.015	0.255	99	87	67	3	103.5
4	75	161	1.628	0.019	0.324	97	87	66	4	105.9
5	80	163	1.869	0.025	0.425	101	87	64	4	105.5
6	85	164	1.991	0.028	0.475	102	88	64	4	105.4
7	90	164	1.908	0.027	0.458	104	89	60	4	102.9
8	95	163	1.911	0.026	0.442	105	89	58	5	105.0
9	100	163	1.867	0.025	0.425	103	90	58	5	104.9
10	105	162	1.879	0.025	0.427	105	90	58	5	105.2
11	110	160	1.887	0.025	0.428	105	90	59	5	105.3
12	115	159	1.627	0.019	0.325	108	91	59	4	104.1
Average or total	120	161	40.921	0.022	0.369	--	--	--	--	103.4

FIELD DATA SHEET

Plant Border Chemical Company Limited Location NE corner of Day Street and Gunn Road, R.M. of Springfield

Stack Absorber tower exhaust Test number 3 Date July 12, 1984

Ambient temperature (°F) 84 Barometric pressure (in. Hg) 29.01 Time 9:44 A.M. to 11:50 A.M.

Nozzle diameter (in.) 0.367 Probe length/type 5 foot/glass lined Stack static pressure (in. H_2O) +0.02

Probe temperature (°F) 220 to 263 Filter holder temperature (°F) _____ Leak check 0.02 CFM @ 10 " Hg Vacuum

Traverse point number	Clock time, start	Stack gas temperature, °F	Gas meter volume, cu. ft.	Velocity pressure, in. H_2O	Orifice pressure drop in. H_2O	Gas meter temperature, °F		Final impinger Temperature, °F	Pump vacuum in. H_2O	Isokinetic factor, %
						Inlet	Outlet			
E 1	0	142	1.365	0.015	0.264	100	88	64	3	98.1
2	5	155	1.555	0.019	0.324	107	88	59	3	99.1
3	10	156	1.781	0.024	0.411	114	90	60	4	100.0
4	15	154	1.957	0.028	0.484	117	92	60	4	101.2
5	20	155	2.039	0.030	0.521	120	94	60	4	102.0
6	25	156	2.046	0.030	0.521	123	96	60	4	102.0
7	30	156	2.055	0.030	0.523	123	97	61	4	102.4
8	35	155	2.107	0.031	0.542	124	98	62	4	102.6
9	40	155	2.225	0.035	0.613	126	99	62	4	102.0
10	45	155	2.220	0.034	0.597	126	99	62	4	102.7
11	50	154	2.188	0.033	0.580	126	99	64	4	103.0
12	55	153	1.905	0.025	0.440	125	99	64	4	103.5
Average or total										

FIELD DATA SHEET

Traverse point number	Clock time	Stack gas temperature, °F	Gas meter volume, cu. ft.	Velocity pressure, in. H_2O	Orifice pressure drop in. H_2O	Gas meter temperature, °F		Final impinger Temperature, °F	Pump vacuum in. H_2O	Isokinetic factor, %
						Inlet	Outlet			
N 1	60	143	1.561	0.017	0.305	114	97	61	3	102.6
2	65	150	1.711	0.020	0.353	114	96	61	3	104.1
3	70	154	1.725	0.021	0.367	117	96	61	3	102.8
4	75	154	1.873	0.024	0.420	119	97	61	4	103.8
5	80	154	1.940	0.026	0.455	118	96	61	4	104.2
6	85	155	2.053	0.029	0.507	118	96	61	4	103.7
7	90	155	2.255	0.035	0.611	118	96	63	4	104.4
8	95	155	2.226	0.034	0.594	115	96	64	4	104.3
9	100	154	2.206	0.034	0.595	117	96	64	4	103.0
10	105	154	2.127	0.031	0.542	115	95	65	4	104.5
11	110	153	1.985	0.027	0.472	118	96	65	4	104.2
12	115	151	1.909	0.025	0.439	118	96	65	4	104.3
Average or total	120	153	47.014		0.478	--	--	--	--	102.7

APPENDIX D: Analytical Report

SO_x STACK EMISSIONS REPORT SHEET

Plant Border Chemical Ltd
Location Winnipeg
Received from K. Reeve
Report to K. Reeve
Date Sampled July 10, 11, 12, 1984
Date Received July 13 1984

Analysis H_2SO_4 Mist and SO_2
Method No. EPA Method 8
Date Analyzed July 18, 1984
Analyst D. Fritz
Report Date July 19, 1984
Report No. 542

Vsoln = total sample volume collected, ml.
Va = sample aliquot titrated, ml.
$\bar{V}t$ = average volume of barium chloride titrant used per sample aliquot, ml.
Vtb = average volume of barium chloride titrant used per blank aliquot, ml.
Normality of BaCl2 = 0.0102.

RESULTS:

		Sulphuric Acid Mist				Sulphur Dioxide			
Lab #	I.D.	Vsol'n	Va	$\bar{V}t$	$\bar{V}tb$	Vsol'n	Va	$\bar{V}t$	$\bar{V}tb$
13054	RUN 1 IMPINGER 1	250	20.0	25.60	0.02	—	—	—	—
13055	RUN 1 IMPINGERS 2+3	—	—	—	—	1000	10.0	59.30	0.41
13056	BLANK 80% ISOPROPANOL	—	100.0	0.02	0.02	—	—	—	—
13057	BLANK 3% H_2O_2	—	—	—	—	—	100.0	0.41	0.41
13058	RUN 2 IMPINGER 1	250	20.0	33.62	0.02	—	—	—	—
13059	RUN 2 IMPINGERS 2+3	—	—	—	—	1000	10.0	68.20	0.41
13060	RUN 3 IMPINGER 1	250	20.0	26.04	0.02	—	—	—	—
13061	RUN 3 IMPINGERS 2+3	—	—	—	—	1000	10.0	54.00	0.41

D. Fritz

P/rb
Lab. No. 225